

WE CLAIM:

1. A preheating apparatus for particulate material comprising:
 - (A) a lower chamber comprising (i) a sloped floor having a center section and an outer annular preheating section which circles the center section; (ii) a material outlet located in the vicinity of the center section for discharging preheated particulate material out of the chamber; (iii) a roof having a perimeter, an upper side, a lower side and a plurality of holes that extend therethrough, each of which are located near the perimeter of the roof and which are arranged in a circular array; (iv) vertical side walls which extend from the perimeter of the roof to the floor; (v) a gas inlet for receiving hot gas into the chamber for flow in countercurrent heat exchange with the particulate material and (vi) means for moving particulate material in the lower chamber toward the material outlet; and
 - (B) an upper preheating and material delivery area comprising a plurality of essentially vertically oriented, elongated hollow feed cassettes for preheating particular material which travels down through each cassette by gravity and for delivering said preheated material to the outer annular section of the lower chamber through the holes in the roof to form material piles on the outer annular section, each cassette having
 - (i) a top and a bottom; and
 - (ii) a material inlet located near its top;
 - (iii) gas outtake means, located near its top, for collecting gas that has passed through particulate material in countercurrent heat exchange, and directing said gas out of the preheater; and
 - (iv) a gas inlet, located at its bottom, for receiving preheating gas that passes through the holes in the roof from the lower chamber;

wherein each cassette is positioned over at least one hole, and wherein said cassettes are not in contact with and are spaced from each other and are spaced from the perimeter of the roof; and

2. The apparatus of claim 1 wherein the cassettes are evenly spaced from each other.
3. The apparatus of claim 1 wherein the cassettes are evenly spaced from the perimeter of the roof.
4. The apparatus of claim 1 wherein at least one cassette is cylindrical.
5. The apparatus of claim 1 wherein at least one cassette has a truncated conical shape.
6. The apparatus of claim 1 wherein at least one cassette has, at its bottom, a symmetrical horizontal cross section.
7. The apparatus of claim 6 wherein said at least one cassette has, at its bottom, a circular horizontal cross section.
8. The apparatus of claim 1 wherein the bottom of at least one cassette extends through a hole and into the lower chamber.
9. The apparatus of claim 1 wherein the number of cassettes are equal to the number of holes in the roof.
10. The apparatus of claim 1 wherein the roof is flat.
11. The apparatus of claim 10 wherein the perimeter of the roof has a knuckle profile.
12. The apparatus of claim 1 wherein the means for moving particulate material in the lower chamber is a plurality of reciprocally movable ram-type material pushers for moving particulate material through the chamber toward the material outlet, with there being a pusher underneath each cassette.
13. The apparatus of claim 12 wherein the reciprocally movable ram-type material pushers have an upper and lower surface and a front face and rear end, wherein the upper surface of the material pusher has at least two steps, with the step closest to the front face being

the lowest, and with successive step toward the rear end being higher than the preceding step.

14. The apparatus of claim 1 wherein the material inlet is located directly above the gas outtake means so that material passing through the material inlet will fall on top of the gas outtake means.
15. A preheating apparatus for particulate material comprising:
 - (A) a basically circular lower chamber comprising (i) a sloped floor having a center section and an outer annular preheating section which circles the center section; (ii) a material outlet located in the vicinity of the center section for discharging preheated particulate material out of the chamber; (iii) a flat, essentially circular roof having a perimeter, an upper side, a lower side and a plurality of holes that extend therethrough which are arranged in a circular array near the perimeter of the roof; (iv) vertical side walls which extend from the perimeter of the roof to the floor; (v) a gas inlet for receiving hot gas into the chamber for flow in countercurrent heat exchange with the particulate material; and (vi) means for moving particulate material in the lower chamber toward the material outlet; and
 - (B) an upper preheating and material delivery area comprising a plurality of essentially vertically oriented, elongated hollow feed cassettes for preheating particular material which travels down through each cassette by gravity and for delivering said preheated material to the outer annular section of the lower chamber through the holes in the roof to form material piles on the outer annular section, each cassette being evenly spaced from each other evenly spaced from the perimeter of the roof, and having
 - (i) a top and a bottom; and
 - (ii) a material inlet located near its top;

(iii) a gas outlet, located near its top, for receiving gas has passed through particulate material in countercurrent heat exchange, with said gas exiting the cassette through a gas duct connected to the gas outlet;

(iv) a gas inlet, located at its bottom, for receiving preheating gas through that passes through the holes in the roof from the lower chamber; and

(v) a truncated conical shape and a symmetrical horizontal cross section;

wherein each cassette is positioned over at least one hole, and wherein said cassettes are not in contact with and are spaced from each other and are spaced the perimeter of the roof.

16. The apparatus of claim 15 wherein the bottom of at least one cassette extends through a hole and into the lower chamber.
17. The apparatus of claim 15 wherein the number of cassettes are equal to the number of holes in the roof.
18. The apparatus of claim 15 wherein the perimeter of the roof has a knuckle profile.
19. The apparatus of claim 15 wherein the means for moving particulate material in the lower chamber is a plurality of reciprocally movable ram-type material pushers for moving particulate material through the chamber toward the material outlet, with there being a pusher underneath each cassette.
20. The apparatus of claim 19 wherein the reciprocally movable ram-type material pushers have an upper and lower surface and a front face and rear end, wherein the upper surface of the material pusher has at least two steps, with the step closest to the front face being the lowest, and with successive step toward the rear end being higher than the preceding step.
21. The apparatus of claim 15 wherein the material inlet is located directly above the gas outtake means so that material passing through the material inlet will fall on top of the gas outtake means.

22. The apparatus of claim 15 wherein the duct will exit the cassette at no more than a 45-degree angle from the vertical.
23. A preheating apparatus for particulate material comprising: a preheating vessel having a floor, a ceiling and sidewalls; a material inlet for receiving particulate material into the vessel; a material outlet for discharging preheated particulate material out of the vessel; a gas inlet for receiving hot gas into the vessel; a gas exhaust for discharging gas from the vessel after the gas has passed through the particulate material in the vessel; and a reciprocally movable ram-type material pusher, having an upper and lower surface and a front face and rear end, for moving particulate material through the chamber toward the material outlet, wherein the upper surface of the material pusher has at least two steps, with the step closest to the front face being the lowest, and with successive step toward the rear end being higher than the preceding step.
24. A preheating apparatus for particulate material comprising:
- (A) a secondary preheating chamber comprising (i) a sloped floor having a center section and an outer preheating section which circles the center section; (ii) a material outlet located in the vicinity of the center section for discharging preheated particulate material out of the secondary chamber; (iii) a gas inlet for receiving hot gas into the chamber for flow in countercurrent heat exchange with the particulate material; and (iv) means for moving particulate material in the lower chamber toward the material outlet; and
 - (B) at least one initial preheating chamber comprising an inlet for particulate material to be preheated, a gas inlet for receiving hot gas that has exited the secondary chamber for flow in countercurrent heat exchange with the particulate material; a material outlet located in the vicinity of the center section for discharging preheated particulate material out of the initial chamber, a material

outlet, and a gas outlet through which hot gas that has passed through the particulate material in the initial chamber will exit said initial chamber; wherein the material outlet of the initial chamber is flow connected to the material inlet of the secondary chamber.

25. The apparatus of claim 24 wherein the means for moving particulate material in the lower chamber is at least one reciprocally movable ram-type material pusher for moving particulate material through the chamber toward the material outlet.